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## THE DIFFERENTIAL HEAT OF ADSORPTION OF WATER VAPOR OF RUTYLE AT DIFFERENT SURFACES

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## THE DIFFERENTIAL HEAT OF ADSORPTION OF WATER VAPOR OF RUTYLE AT DIFFERENT SURFACES

Cover Page Footnote

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Erratum

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## THE DIFFERENTIAL HEAT OF ADSORPTION OF WATER VAPOR OF RUTYLE AT DIFFERENT SURFACES

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**Abstract:** *In this work, the full thermodynamic characteristics of absorbing water vapor of rutyle are studied. The relevance between crystal-chemical structure in rutyles and adsorption-energetic features have been found, and the adsorption molecular mechanism in all parts saturation of titanium four oxide with water vapor has been determined.*

**Key words:** *adsorption, thermodynamic, adsorbent-energetic, titanium (IV) oxide, water.*

## РУТИЛНИНГ ТУРЛИ ХИЛ ЮЗАЛАРДА СУВ БУҒИНИНГ АДСОРБЦИЯСИ ДИФФЕРЕНЦИАЛ ИССИҚЛИКЛАРИ

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**Annotatsiya:** *Ушбу ишда рутил юзаларидаги сув адсорбциясининг тўлиқ термодинамик хусусиятлари ўрганилган ва ёритиб берилган. Рутил ва энергетик адсорбцион хусусиятлардаги кристал-киёвий структура ўртасидаги алоқалар аниқланди ва барча adsorption molekulyar mexanizm titan to'rt oksidning suv bug'lari bilan to'yinganligi aniqlandi.*

**Калит сўзлар:** *адсорбция, термодинамика, адсорбция-энергетикаси, титана (IV) оксиди, сув.*

## ДИФФЕРЕНЦИАЛЬНАЯ ТЕПЛО АДСОРБЦИЯ ВОДНОГО ПАРА РУТИЛА НА РАЗЛИЧНЫХ ПОВЕРХНОСТЯХ

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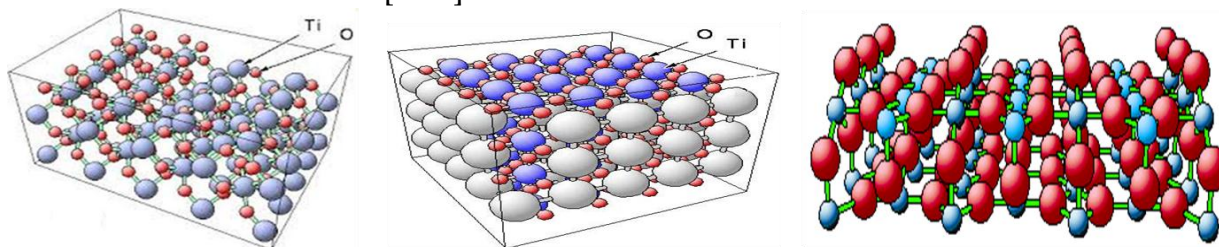
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**Аннотация:** В этой работе изучаются полные термодинамические характеристики поглощения водяного пара рутила. Найдена актуальность между кристаллохимической структурой в рулях и адсорбционно-энергетическими особенностями, и был определен молекулярный механизм адсорбции во всех частях насыщения четырехоксида титана водяным паром.

**Ключевые слова:** адсорбция, термодинамика, адсорбционно-энергетическая, диоксида титана, вода.

**Introduction.** The Rutile is one of the most-used substances in the world. Reason for this is that the molecular state of substances adsorbed into the surface of titanium four oxide is like a liquid. The surface of rutile mainly has three types of adsorptive features<sup>3</sup>. Of these, gran adsorptive feature is the highest one. That's way, rutile is profoundly used in industry and technics. The surface of the rutile is essentially of 3 different granites. 100 101, 110 of which are known to be extremely high, are known to be adsorbed [3-11].

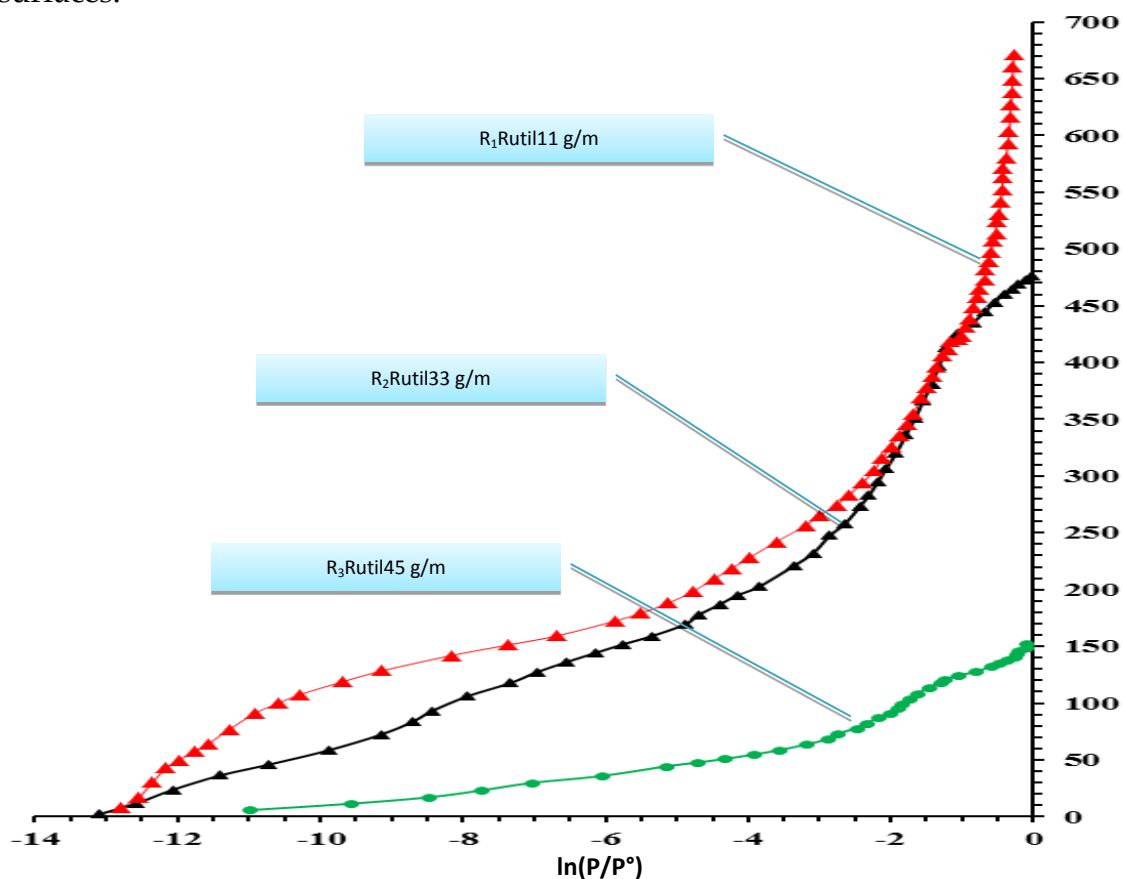


Our purpose is to fully study hydrodation mechanism of titanium four oxide by means of calorimetric method. Precision structure-sensing methods are paid attention in studying Guest-host link. This method gives information about the crystallchemistry of surface, its chemistry and physics as well as the combining mechanism in molecules at active centres in the surface of a solid object [9,10] .

Research methods and objects. The research has been conducted in the adsorbtion calorimetric device with high vacuum. The results found in this device have a high accuracy. The differential heat of adsorbtion has been determined in the automatic calorimeter of Tian-Calve [2]. The isotherm of adsorbtion has been measured in a volume method. The dosage of adsorbtion has been performed applying a volume-liquid method. The accuracy of isotherms measured is 0,1 %, while adsorbtive heat is equal to 1% , and this method shows all features of adsorbent, determining the thermodynamic features of adsorbent.

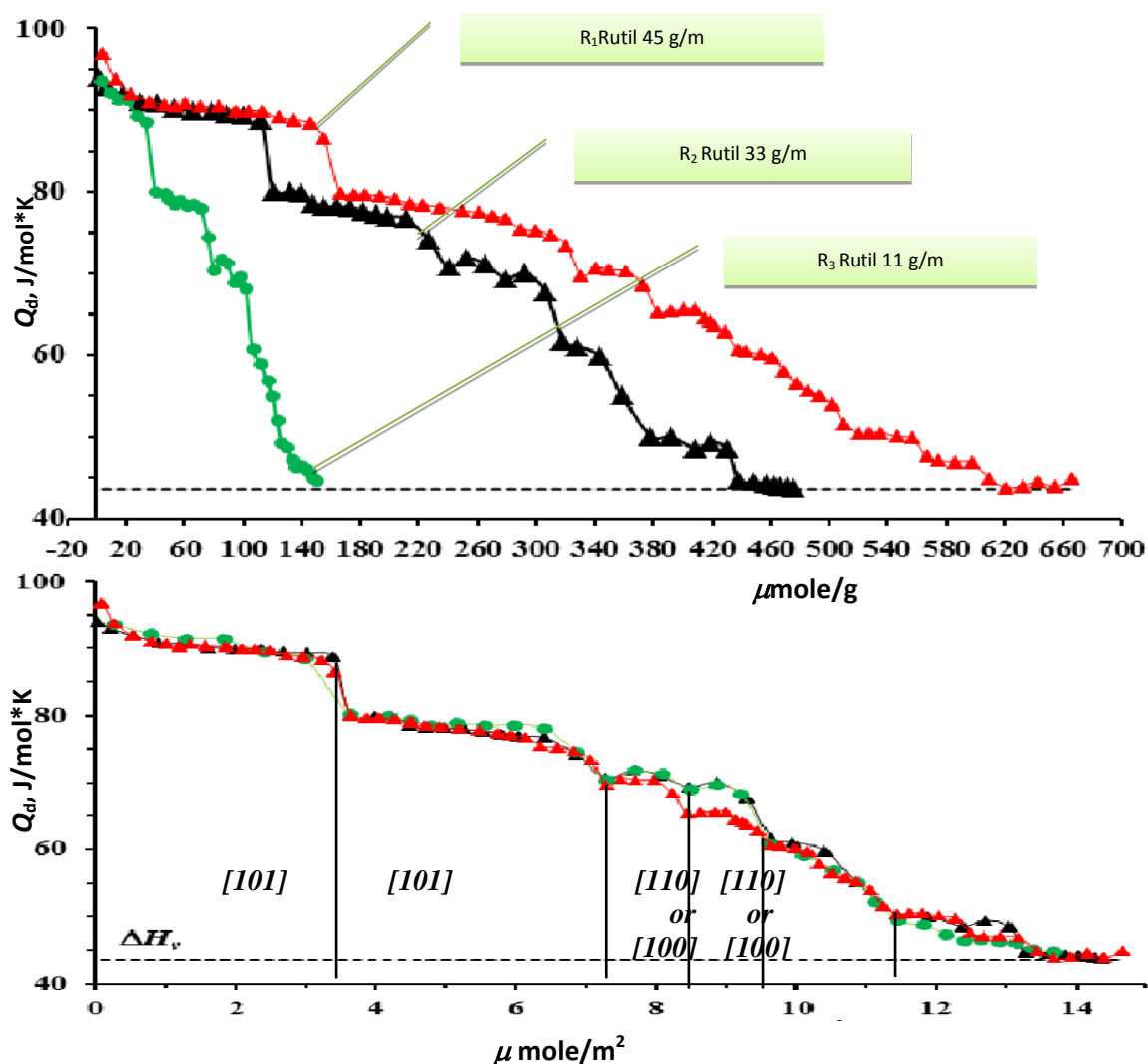
**The outcomes achieved and discussing them.** The adsorbtive isotherm of water in  $TiO_2$  has been measured at 303K. The lines which illustrate the links that occur at constant temperature on the diagrams of occurrences of heat show that the adsorbtive isotherm of water in  $TiO_2$  and changing of pressure was poor and, in each rutyle, the adsorbtions of surfaces is accordingly 160, 500 ва 700 mkmol/g [1]. The isotherm on the BET equation coordination between relative pressure is in the form of line. When

calculated with BET equation, it has been found that rutyle surfaces fit suitable surfaces.



The isotherm of water adsorption in rutyls measured at 300K

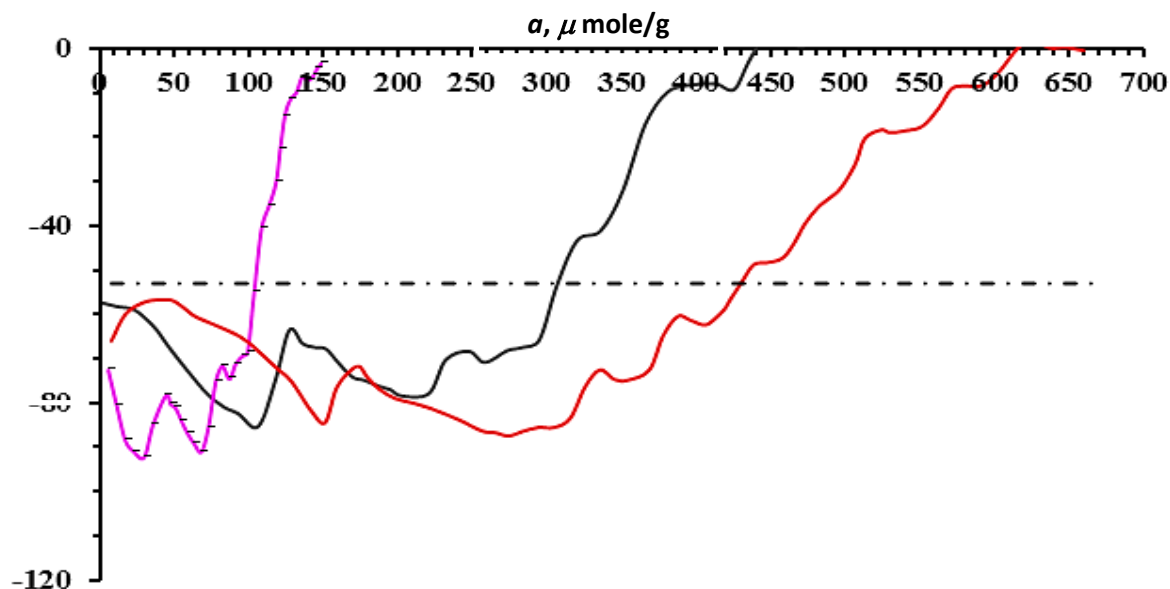
The heat absorption decreases gradually to a condensation temperature of about 43.5 kJ/mol at 303 K, starting from 95 kJ/mol. The total is 680  $\mu\text{mol/g}$  water adsorbed. This is a very high capacity capability for minerals that are not present. Weighing up to 680  $\mu\text{mol/g}$ , we observe 2 links of 166  $\mu\text{mol/g}$  in adsorbed state. The first and the second steps indicate that the rutile surface [110] is hemostation in the granules. Then it will be  $\sim 52 \mu\text{mol/g}$  in the second stage of adsorption. In this case water molecules are adsorbed molecules [100] or [101] in granules. Then the continuous plate ends at Qd line at 684.8  $\mu\text{mol/g}$ . When the water is first adsorbed into two granular grains at  $\sim 166 \text{ mkmol/g}$ , smaller granules contain about 52 mkmol/g water adsorption in two surfaces. At the end of the experiment,  $\sim 166 \text{ mkmol/g}$  of water was adsorbed. The result of the BET equation indicates that the surface in the  $\text{TiO}_2$  molecule is filled with water monomolecule[2].



Picture 2. Differential temperature of  $\text{TiO}_2$  in water adsorption

Formation of the monomolecular layer on the surface of the rutile is accompanied by the steps in the  $Q_d$  line. Indicates the formation of a two-dimensional complex  $(\text{H}_2\text{O})_2 \cdot \text{TiO}_2$  with the same oxidation surface ( $166 \mu\text{mol/g}$ ) of the first two longitudinal step. Thus, the adsorption of water results in a three-fold increase in the amount of cationic surfactant from neighboring layers.

From previous experiments, we know that using the Gibbs-Gelmgolts equation (DSd), using the differential adsorption heat and isotomic water, we calculated the differential entropy of adsorption. Figure 3 shows the differential entropy of adsorption 303 K. Vertical strips - the integral entropy for water at 300K.



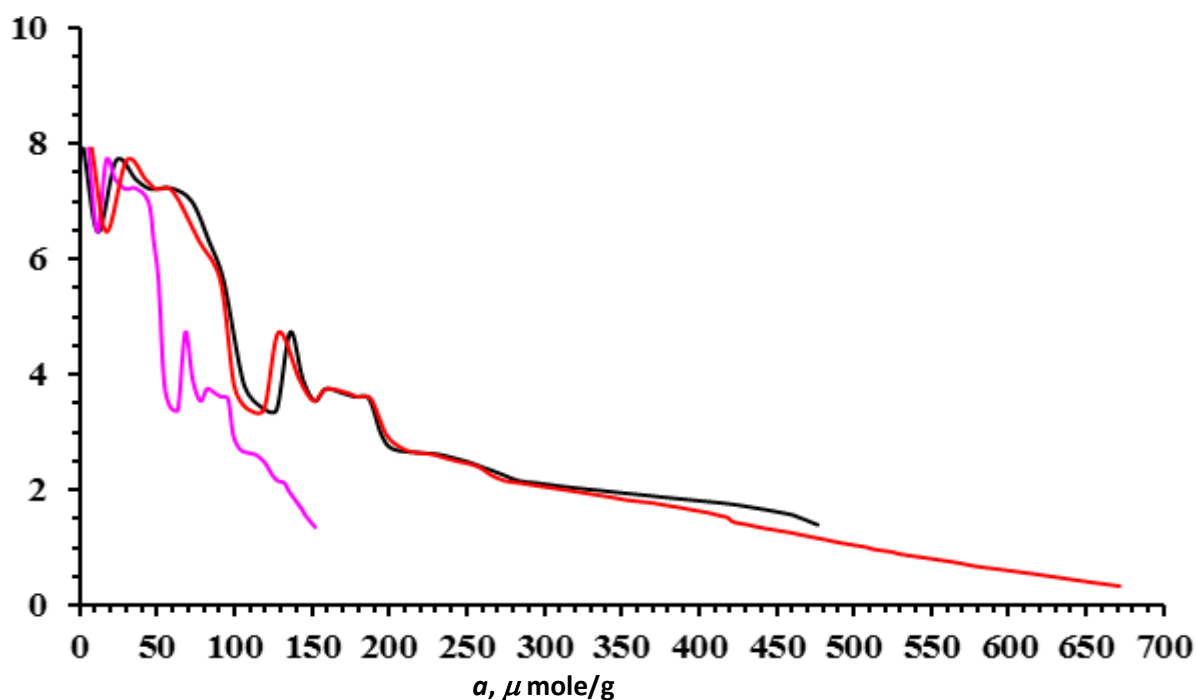
Picture3. In 300K,  $\text{TiO}_2$  is a water molecule (DSd) differential entropy of adsorption

Given the entropy heat level, the line has a wavy appearance. Almost half of the line is below the water entropy line and the rest are above the water entropy line. In general, the mean entropy value is  $\sim 52 \text{ J / mol} \cdot \text{K}$ . Rutile Water Absorption Water molecules that are hemostatized in the first and the second stages will be unstable. The integral entropy of adsorbing against the entropy of water is less than  $\sim 9.1 \text{ Dj / mol} \cdot \text{K}$ . This result is lower in the  $\text{H}_2\text{O}$ -rutile system than in the liquid water flow.

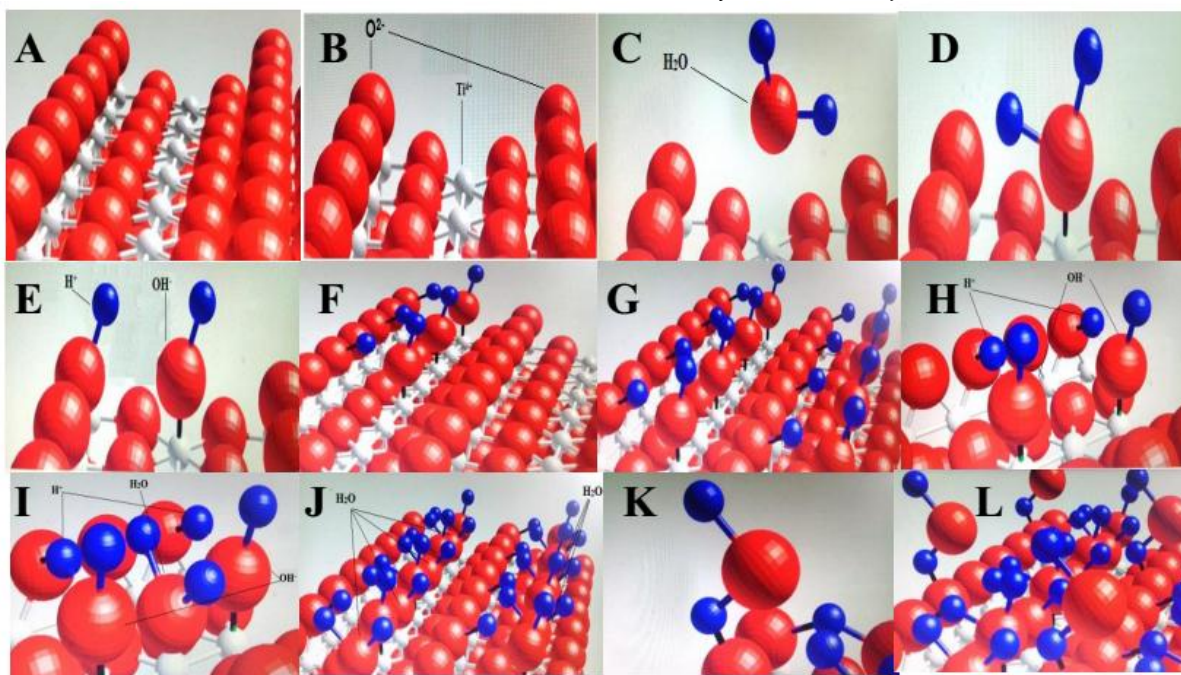
In all calorimetric experiments we have obtained thermokinetic lines. It is possible to observe the adsorption equilibrium over time (Fig. 4). Adjusting the adsorption balance around the first high energy nucleus will suddenly slow down and last for 8 to 2 hours. The slowdown in the process depends not only on the water surface resettlement.

The adsorption has a differential heat-stained appearance.





Picture 4.303 K in the titanium oxide, a solution of water adsorption within a timeline.



Picture 5

As you can see from figure 5 (A), the water molecules on the surface of the rutile will first have a chemical bond with  $Ti^{+4}$  cation. That is  $Ti^{+4} H^+ -OH^-$  is bound. Then the water molecules were separated into  $HO^-$  and  $H^+$  ions. The resulting  $H^+$  ions are bonded to the  $O^{2-}$  anions of the rutile surface. Therefore, in the first step, Ti (A) is continuously saturated  $Ti^{+4}$  on the surface of the rutile surface with a uniformity of 95 kJ / mol at the differential temperature. In the elementary cells on the surface of the rutile - ions are started in the proper way. 40 mole/l Water molecules are separated into ions by chemical bonding. At the second stage of the differential heat, the molecular adsorption on the surface of the water molecules rutile. When each  $H^+$  cation is attached to the  $OH^-$  and  $O^{2-}$  anions, water molecules are added to  $Ti^{+4}$  cations. The reason for



this is that in the process of separation of the previous water molecules, the cationic effect of  $Ti^{+4}$  in the interval increases. And its accumulation decreases. As a result, water molecules are adsorbed to  $Ti^{+4}$  cations. In the second stage, the differential heat continues to rise up to 40 moles/l of water in a uniform 65 kJ/mol range. The adsorbing of the water onto the rutile surface is initially carried out at [110] granules. A total of 26 mol/l [100] and [101] granules are subjected to water adsorption on two stages of 13 mol/l following the granulation of the granules. And finally, water adsorbs in [110] granules. At the same time, the water molecule H-hydrogen bonding occurs on the  $O^{2-}$  anion. In the final stage, the water to the line of condensation

**Summary.** Water vapor adsorption in Rutile is in step 7. In the first and second phases, the water is expelled in granules [110] on the rutile surface. Therefore, the differential temperature is 166  $\mu$ mol / g in 330  $\mu$ mol / g in an unstable state. In the next two phases, molecular adsorption of water at 52 mkmol / g [100] and [101] granules. In the latter stage adsorption on the pre-granular surfaces is observed. All stages indicate the stoichiometric ratio of the cations on the surface and the amount of adsorbed water. Rutile water adsorption occurs with the formation of two monomolecular layers on the surface. In the first layer, four water molecules are coordinated. This process is accompanied by sharp deceleration of adsorption kinetics. The molecules on the surface of the rutile resemble a liquid.

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